STANDARD OPERATING PROCEDURE

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Purging Wells for Representative Sampling of Groundwater	**ER-SOP-6.01**	**1**	**03/08/99**

ER PROJECT

APPROVALS FOR USE

Author's Name (Print):	Author's Signature:	Date:
Jennifer Pope	**Signature on file**	**03/08/99**
Quality Program Project Leader's Name (Print)	Quality Program Project Leader's Signature	Date:
Larry Maassen	**Signature on file**	**03/08/99**

LOS ALAMOS NATIONAL LABORATORY

Purging Wells for Representative Sampling of Groundwater

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Purging Wells for Representative Sampling of Groundwater

NOTE: Environmental Restoration (ER) Project personnel may produce paper copies of this procedure printed from the controlled document electronic file. However, it is their responsibility to ensure that they are trained on and utilizing the current version of this procedure. The procedure author may be contacted if text is unclear.

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes methods for evacuating stagnant water from a well bore in sufficient quantities so that the water samples that are collected afterwards are representative of the formation interval open to the well bore.

2.0 TRAINING

2.1 All users of this SOP are trained by self-study, and the training is documented in accordance with QP-2.2.

2.2 The **Field Team Leader** (FTL) will monitor the proper implementation of this procedure and ensure that relevant team members have completed all applicable training assignments in accordance with QP-2.2.

3.0 DEFINITIONS

3.1 *Hydrogen-ion activity (pH)* — The effective concentration (activity) of dissociated hydrogen ions [H^+]. A measure of the acidity or alkalinity of a solution, numerically equal to 7 for neutral solutions, increasing with alkalinity and decreasing as acidity increases.

3.2 *Redox potential (Eh)* — Chemical reactions whereby a participating element changes its valence state by losing or gaining orbital electrons. This may be referred to as oxidation-reduction potential.

3.3 *Site-Specific Health and Safety Plan (SSHASP)*—A health and safety plan that is specific to a site or ER-related field activity that has been approved by an ER health and safety representative. This document contains information specific to the project including scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g., personal protective equipment [PPE]) and hazard mitigation.

3.4 *Specific (electrical) conductance* — A measure of the ease with which a conduction current flows through a substance under the influence of an applied electric field. It is dependant upon the presence of ions (total and relative concentrations, valence, and mobility) and temperature. It is the reciprocal of resistivity and is measured in either siemens (S) or micro-ohms per centimeter (μohm/cm) at 25°C.

3.5 *Turbidity (nephelometric)* — A measure of the intensity of light scattered by sample particulates relative to a standard reference suspension. The range of water turbidity is measured from 0 to 40 nephelometric turbidity units (NTU).

4.0 BACKGROUND AND PRECAUTIONS

Note: This SOP is to be used in conjunction with an approved SSHASP. Also, consult the SSHASP for information on and use of all PPE.

4.1 Background

4.1.1 Groundwater that is stagnant in the well bore is subject to chemical reactions that may significantly alter the composition of the formation water that initially entered the borehole. This stagnant water will no longer be representative of the water in the formation.

4.1.2 Upon exposure to atmospheric pressure and atmospheric oxygen content, the well water oxidation-reduction potential (Eh) and hydrogen-ion activity (pH) are subject to change. Reactions with the casing material may also affect water composition. Solubility may increase, which would allow the water to dissolve constituents that under normal conditions would remain in the formation; or solubility may decrease, which could cause constituents to precipitate that under normal conditions would migrate through the aquifer in solution.

4.1.3 A well should be purged until the water temperature, specific conductivity, and pH stabilize, and the turbidity should be less than 5 NTU, to make it possible to collect groundwater samples that are representative of the formation water. Samples collected after the well has been purged can then be sent to a laboratory for analysis.

4.1.4 The choice of equipment for well evacuation depends on the well yield, depth to water, casing diameter, the required analysis, and the requirements in the Site Work Plan and Sampling and Analysis Plan (SAP). The decision to use any well-evacuation system, whether it is one listed in Section 5, below, or not, should be based on what is best for that particular situation.

4.2 Precautions

All waste generated from well development must be handled in accordance with ER-SOP-1.06.

5.0 EQUIPMENT

A checklist of suggested equipment and supplies for this procedure is provided in Attachment A. Descriptions of commonly used well-evacuation systems, their advantages, and their limitations are listed below.

5.1 Bailer

5.1.1 With a stainless steel or Teflon bailer, water is removed from the well bore by a vessel of known volume. The vessel fills with water, and the unit is retrieved with a line or rope. The bailer purges the well's entire water column by removing standing water at the groundwater surface. Recharge is pulled into the well from the screened interval below.

5.1.2 For shallow, small-diameter wells with low yields, evacuation of the well by bailer is recommended. Bailers are mechanically simple, lightweight and highly portable, constructed in many sizes, and require no external power source. Bailers are easily operated and cleaned and are inexpensive. In addition, considerable time and cost savings are possible by using dedicated equipment to reduce the decontamination task and to limit the possibility of cross-contamination (EPA, 1991).

5.1.3 The primary limitation of bailers is their limited-volume purging capability, especially in deep wells where purging is labor intensive and time consuming. Bailers may also disturb the water by the pressure changes created by purging. Another disadvantage is that sampling personnel are directly exposed to any contaminants present. When bailers are used, care must taken to prevent dropping or catching the bailer in the well, and care must be taken not to let the bailer line or bailer come in contact with the ground.

5.2 Bladder Pump

5.2.1 The pump assembly is suspended from the discharge tubing and submerged in the well. Water is transported through the discharge tube to the surface by positive gas displacement. A portable air compressor or bottled nitrogen is used to drive the pump.

5.2.2 Dedicated Teflon bladder pumps are recommended to minimize the introduction of contamination into the well. The maximum sample depth for a bladder pump is 400 ft. A bladder pump has an adjustable flow rate to allow purging at high rates and sampling at a low rate and causes very little agitation of the water.

5.3 Reciprocating Piston Submersible Pump

5.3.1 The pump assembly is suspended from the discharge tubing and submerged in the well. Water is transported through the discharge tube to the surface by piston action. A portable air compressor is used to drive the pump.

5.3.2 The reciprocating piston submersible pump is a portable system that can purge wells where the depth to the water's surface is up to 500 ft. These pumps develop high pumping rates and can be operated in 2-in.-diameter wells. The pump is self-priming, and the compressed gas (air or nitrogen) that drives the pump does not contact the purged water. The pump is constructed from stainless steel or Teflon and can be decontaminated easily.

5.4 Electric Submersible Pump

5.4.1 The pump assembly is suspended from the discharge tubing and submerged in the well. The turbine in the pump bowl creates sufficient pressure to force water up the discharge pipe. Usually, a portable generator is required to power the electric pump (unless electricity is available) and a truck-mounted winch may be required to move and lower the pump into the well.

5.4.2 The submersible pump may be used for purging both shallow, small-diameter wells and deep, large-diameter wells that require large rates of discharge. Manufacturers offer small-diameter pumps constructed of stainless steel and Teflon that are capable of efficient purging at significant depths. The pump may be portable and self-contained.

5.4.3 Disadvantages of the submersible pump are that

- the pump can be difficult to decontaminate and transport along with auxiliary equipment;
- the pump motor may be damaged by dry pumping;
- the gears may be damaged by water that contains high levels of suspended sediment;
- large-capacity pumps are expensive; and
- with negative displacement, pumps can significantly aerate the sample, thus changing the in situ chemistry and stripping low-molecular-weight volatiles.

Careful monitoring during operation is needed to obtain optimum pump performance and to preclude the possibility of equipment damage.

6.0 PROCEDURE

Note: Deviations from SOPs are made in accordance with QP-4.2.

The following procedure for purging a well is applicable regardless of which pump has been selected to best meet the constraints of the job. For procedural variations or additions specific to the type of pump used, follow the general instructions.

6.1 Preliminary Activities

6.1.1 Make provisions for proper storage and disposal of the extracted well water, as described in ER-SOP-1.06 and coordinate your sampling effort with the data-support technician assigned to the Focus Area.

6.1.2 Assemble the equipment and supplies listed in Attachment A.

6.1.3 Verify that the equipment and meters are in good working order. Calibrate the meters with the appropriate calibration standards. Refer to ER-SOP-6.02 for instructions on how to properly calibrate meters.

6.1.4 In the field, locate the monitor wells to be sampled and the appropriate staging and decontamination areas.

6.1.5 Place new plastic sheeting on the ground around the well in case something is dropped or must be placed on the ground.

6.1.6 Decontaminate the equipment that will come into contact with the groundwater sample both before sampling the first well and in between sample efforts in accordance with ER-SOP-1.08, Field Decontamination of Drilling and Sampling Equipment. Use new rope for bailers.

6.1.7 Measure and record the depth to water in the well, if possible, from the reference point established for that well, in accordance with ER-SOP-7.02. Also, measure the total depth of the well.

6.1.8 Determine the well bore volume as defined by the following relationship:

$$V = \frac{(d^2)\pi}{4}(h_2 - h_1) \times 7.48$$

Where V = volume, in gallons

π = constant 3.1416

d = well diameter, in feet

h_1 = depth to water, in feet

h_2 = well's total depth, in feet

7.48 = gallons per cubic foot

Determine the height of the water column standing in the well by subtracting depth to water, in feet, from the total well depth. Measure the well's diameter, in feet. Calculate the volume in gallons and enter these data on the Water Quality Sampling Record (Attachment B—form and completion instructions).

6.1.9 You must extract a minimum of three casing volumes before obtaining a sample. If the well is pumped or bailed dry before sampling, refer to the SAP for guidance.

6.2 Purging

6.2.1 Set the pump intake in the well at the approximate midpoint of the screened interval, if applicable or possible, and begin extraction. Pump intake placement may differ according to site-specific goals. Refer to the SAP for guidance. As the bailer fills, rapidly withdraw it and discharge the water into a bucket.

6.2.2 Periodically record the discharge rate (usually by calibrated bucket and stopwatch) and the time of day on the Water Quality Sampling Record (Attachment B). Also, calculate and tabulate the gallons discharged since the start of purging.

6.2.3 Measure and record the water-quality parameters of the well fluid, as described in ER-SOP-6.02. Consult the SAP to determine which parameters to measure and the proper frequency of measurements. Record the information on the Water Quality Sampling Record (Attachment B).

6.2.4 When a minimum of three times the casing volume of fluid has been extracted, and field pH, specific conductance, and temperature have stabilized, and turbidity is less than 5 NTU, the well is ready to be sampled. If these parameters do not stabilize, refer to the SAP for guidance.

6.2.5 Record the final, stable readings of pH, specific conductance, temperature, and turbidity on the field parameter section of the Water Quality Stabilization Record (Attachment B in ER-SOP-6.02).

6.2.6 After shutting down the pump or bailing is completed, measure and record the water-level drawdown in the well. This data may provide limited information about saturated-zone hydraulics.

6.3 Postoperation Activities

6.3.1 When you have completed sampling, or at the end of the day, carefully clean the outside of the meters with a damp disposable towel to remove any visible dirt. Return them to a secure area and check the battery charge.

6.3.2 Decontaminate the pump assembly and other pieces of equipment that contacted the well fluid in accordance with ER-SOP-1.08.

6.3.3 Restore the site to its original presampling condition.

6.3.4 Store the extracted groundwater as directed in the SAP until its proper disposal can be accomplished.

7.0 REFERENCES

The following documents have been cited within this procedure.

QP-2.2, Personnel Orientation and Training

QP-4.2, Standard Operating Procedure Development

QP-4.3, Records Management

ER-SOP-1.06, Management of Environmental Restoration Project Wastes

ER-SOP-1.08, Field Decontamination of Drilling and Sampling Equipment

ER-SOP-6.02, Field Analytical Measurements of Groundwater Samples

ER-SOP-7.02, Fluid Level Measurements

EPA Region 4, “Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual,” (Environmental Services Division, Athens, GA, 1991).

8.0 RECORDS

The **FTL** is responsible for submitting the following records (processed in accordance with QP-4.3) to the Records Processing Facility.

8.1 Daily Activity Log forms (Attachment E in ER-SOP-1.04, Sample Control and Field Documentation) or information logged in the field notebook that may include

- the instrumentation and calibration information,
- the order of sampling of the wells,
- any comments with regard to the relative levels of contaminants,
- the determination of casing volumes,
- the health and safety monitoring data, and
- the well discharge rate.

8.2 Water Quality Sampling Record (Attachment B)

8.3 Water Quality Stabilization Record (Attachment B in ER-SOP-6.02)

8.4 Groundwater Elevation Form (Attachment B in ER-SOP-7.02)

9.0 ATTACHMENTS

The document user may employ documentation formats different from those attached to/named in this procedure—as long as the substituted formats in use provide, as a minimum, the information required in the official forms developed by the procedure.

Attachment A: Equipment and Supplies Checklist for Purging of Wells for Representative Sampling of Groundwater (1 page).

Attachment B: Water Quality Sampling Record (form and completion instructions) (5 pages)

Equipment and Supplies Checklist for Purging of Wells for Representative Sampling of Groundwater

____ Purging pump or bailer

____ Water level measurement device

____ Calculator

____ Thermometer

____ Conductivity meter (and extra cup)

____ pH meter (and extra probe)

____ Turbidity meter

____ Air compressor or bottled nitrogen (as needed)

____ Standard reference solutions for calibrating specific conductance, pH, turbidity meters

____ Portable generator, if needed

____ 55-gallon drums or other water storage containers

____ Flow measuring equipment

____ Plastic sheeting

____ Buckets

____ Stopwatch

____ Daily Activity Log forms

____ Water Quality Stabilization Record forms

____ Groundwater Elevation forms

____ Variance log

____ Any PPE listed or required in the SSHASP

____ Any additional supplies listed in associated procedures, as needed

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Water Quality Sampling Record

Date/Time ___________________ Sheet ____ of ___

Technical Area ________ Focus Area ________________ Sample Identification ___________________

Site Work Plan _____________________________________

Field Team Member Signature ____

(Print name and title, then sign)

WATER SAMPLED:

_____ Surface; Location ____________________ Lot Control No. ______________________________

_____ Groundwater; Well Number ____________ Sample Type _______________________________

Sampling Period: Start ____________ Complete _______________

Sampling Methods ____

BORE VOLUME CALCULATION*

$$\frac{d^2\pi}{4}(h_2 - h_1) \times 7.48$$

Depth of Well (h_2) (ft) __________________________

Depth to Water (h_1) (ft) __________________________

Well Diameter (d) (ft) __________________________

One Bore Volume (gal.) __________________________

Screened Interval (ft) __________________________

Minimum Purge Volume (gal.) ___________________

Total Volume Withdrawn (gal.) ___________________

Instruments Used ____________________________

____

*Groundwater Only

SAMPLING INFORMATION

Withdrawal Devices ____________________________

Filter Size ___________________________________

Thermometer ID ______________________________

Ec Meter ID __________________________________

pH Meter ID __________________________________

Pump ID _____________________________________

Alkalinity Kit ID ______________________________

Preservation Methods and Comments ____________

____

Initial Groundwater Depth __________________ Sample Groundwater Depth ___________________

PARAMETER MEASUREMENTS WHILE SAMPLING

Potential of Hydrogen-Ion Activity	pH	S.U.	____________________
Specific Conductance	Ec	μohm/cm	____________________
Temperature	Temp	°C	____________________
Dissolved Oxygen	DO	mg/l	____________________
Turbidity	Turb	NTU	____________________

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Water Quality Sampling Record **(continued)**

Date/Time ____________________ Sheet ____ of ___

Technical Area _________ Focus Area _____________ Sample Identification _______________________

Site Work Plan ____

Field Team Member Signature ____

(Print name and title, then sign)

SAMPLE TYPES		SAMPLING METHODS	
D – Duplicate	T – Trip	D – Depth Integrated	BP – Bladder Pump
F – Field	R – Replicate	B – Bailer	PP – Peristaltic Pump
K – Known	A – Acid Blank	C – Composite	SL – Suction Lift Pump
		G – Grab	SP – Submersible Pump
		O – Other	AL – Air Lift Sampler

CALIBRATION INFORMATION

Date/Time of Ec Calibration ____________________________

Standard Solution _____ μohm/cm, Instrument Reading ______ Lot No. ___________ Exp. Date ______

Standard Solution _____ μohm/cm, Instrument Reading ______ Lot No. ___________ Exp. Date ______

Date/Time of pH Calibration ___________________________

Standard Solution _____ pH, Instrument Reading ____________ pH solution Lot No. _________ Date ______

Standard Solution _____ pH, Instrument Reading ____________ pH solution Lot No. _________ Date ______

SHIPPING INFORMATION

Lab(s) Shipped To: __________________ __________________ __________________

Date(s) Shipped: __________________ __________________ __________________

Method of Shipment: __________________ __________________ __________________

Comments ____

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ER-SOP-6.02

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Instructions for Completing a Water Quality Sampling Record

Use an indelible dark-ink pen. Make an entry in each blank. For entry blanks for which no data are obtained (except in Comments section), enter "UNK" for unknown, "N/A" for not applicable, or "ND" for not done, as appropriate. To change an entry, draw a single line through it, add the correct information above it, and date and initial the change. For all forms, complete the following information:

Header Information:

1. Date/Time—The date and time when the measurement was made, in the following formats: DD-MMM-YY (e.g., 01-JAN-91) and the 24-hr clock time (0837 for 8:37 a.m. and 1912 for 7:12 p.m.).
2. Sheet Number—Number all the sheets that are used for this activity, by day or by some practical unit.
3. Technical Area (TA)—Two-digit number which indicates the TA in which the activity is being performed.
4. Focus Area—Focus Area in which the activity is being performed.
5. Sample Identification—Follow ER-SOP-1.04, Sample Control and Field Documentation for sample identification.
6. Site Work Plan—Title of plan.
7. Field Team Member Identification—Print your name and position title, then sign.

Water Sampled:

1. If groundwater is checked, indicate the number of the well being sampled.
2. Lot Control Number—A two-digit number which denotes that a given set of samples should be analyzed as a lot or group.
3. Sample Types—One-character codes that distinguish the type of sample collected. This classification permits the analysis of data for specific groups of samples. The codes are identified at the top of the form's second page.
4. Sample Period—The starting and ending times of sample collection.
5. Sampling Methods—Two-character codes that identify the method used to collect water samples. The codes are identified at the top of the form's second page and defined in ER-SOP-6.01, Purging of Well and Representative Sampling of Groundwater.

Bore Volume Calculation (for groundwater sampling):

1. Depth of Well—Record depth in feet for groundwater sampling.
2. Depth to Water—Record depth in feet for groundwater sampling.
3. Well Diameter—Record diameter in feet for groundwater sampling.
4. One Bore Volume—Calculate volume in gallons using the equation on the form.
5. Screened Interval—Record interval in feet.
6. Minimum Purge Volume—Total volume of well water to be extracted, at a minimum, is three to five bore volumes before sampling may begin.
7. Total Volume Withdrawn—Record the total volume of water withdrawn.
8. Instruments Used—The types of instruments used to obtain measurements, monitor air quality, or facilitate the collection of a sample or test performance.

Sampling Information:

1. Withdrawal Devices—The sampling devices used to collect the samples.
2. Filter Size—Size of filter in use.
3. Thermometer ID—The identification of the thermometer used.
4. Conductivity Meter ID—The control number and manufacturer of the meter used to measure the specific conductance of samples or calibration solutions.
5. pH Meter ID—The control number and manufacturer of the meter used to measure the pH of the samples.
6. Pump ID—Identification of the pump in use.
7. Alkalinity Kit ID—Identification and model or serial number of the alkalinity kit used.
8. Preservation Methods and Comments—Include preservation method, acidified or nonacidified, type of acid (if acid was used to preserve water sample), and any additional information

Parameter Measurements (Recorded at the time the sample is collected.):

1. Potential of Hydrogen-Ion Activity—The pH value in standard units (S.U.).
2. Specific Conductance—The specific conductance of the water sample in micro-ohms per centimeter (μohm/cm) at 25°C.
3. Temperature—The temperature of the water sample in degrees Celsius (°C).
4. Dissolved Oxygen—The dissolved oxygen content of the water sample in milligrams per liter (mg/l).
5. Turbidity—The turbidity of the water sample in nephelometric turbidity units (NTU).

Calibration Information:

1. Date/Time of Ec Calibration—Date and time that the specific conductivity meter was last calibrated.
2. Standard Solution Ec Readings—Record the standard specific conductances of the two solutions used and the readings when the probe was immersed. Include lot numbers and expiration dates of the standard solutions.
3. Date/Time of pH Calibration—Date and time that the pH meter was last calibrated.
4. Standard Solution pH Readings—Record the standard pH values of the two solutions used and the readings when the probe was immersed. Include lot numbers and expiration dates of the standard solutions.

Shipping Information:

1. Include the shipping date and method and the laboratory where the samples were sent.
2. Comments—This is a space for additional information about any entry on the form.